



Crime science and the built environment

VANIA CECCATO, IOANNIS IOANNIDIS, GABRIEL GLIORI, ONATAN ABRAHAM
UCS - URBAN & COMMUNITY SAFETY RESEARCH GROUP

Session: Urban Environment, Place Management and Safety

Crime Science Workshop
24 September 2026

CITY + SAFE + PLANNING

UCS - URBAN & COMMUNITY SAFETY RESEARCHGROUP

#Safety_challenges

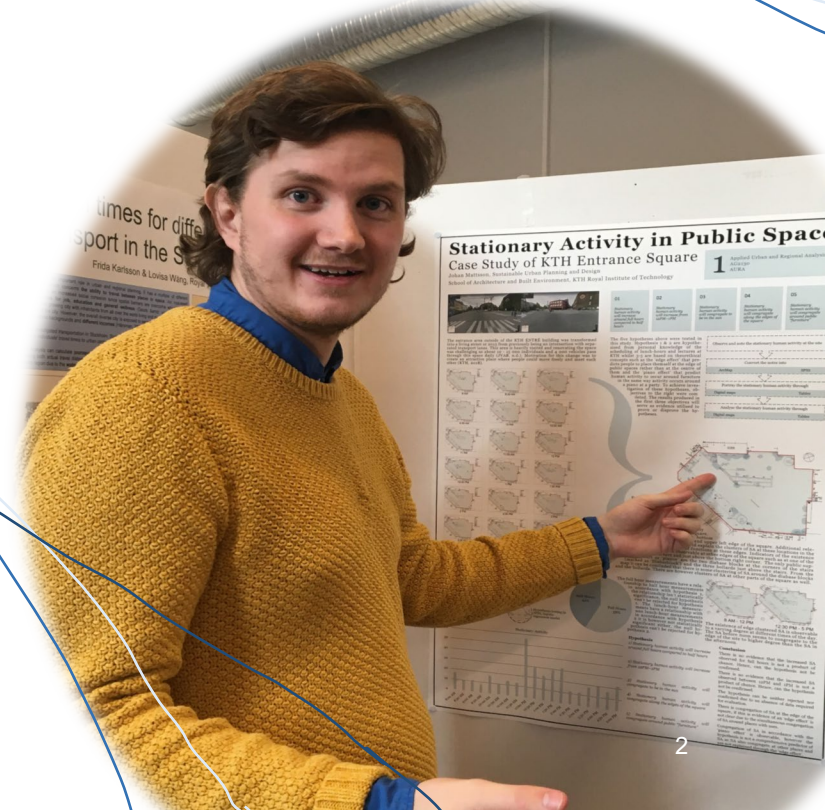
The platform is a co -creative innovation initiative in which city users collaborate with researchers and practitioners to design, experiment with, and evaluate solutions for safer, healthier, and more inclusive built environments.

#Healthy_City



#Analytical_skills

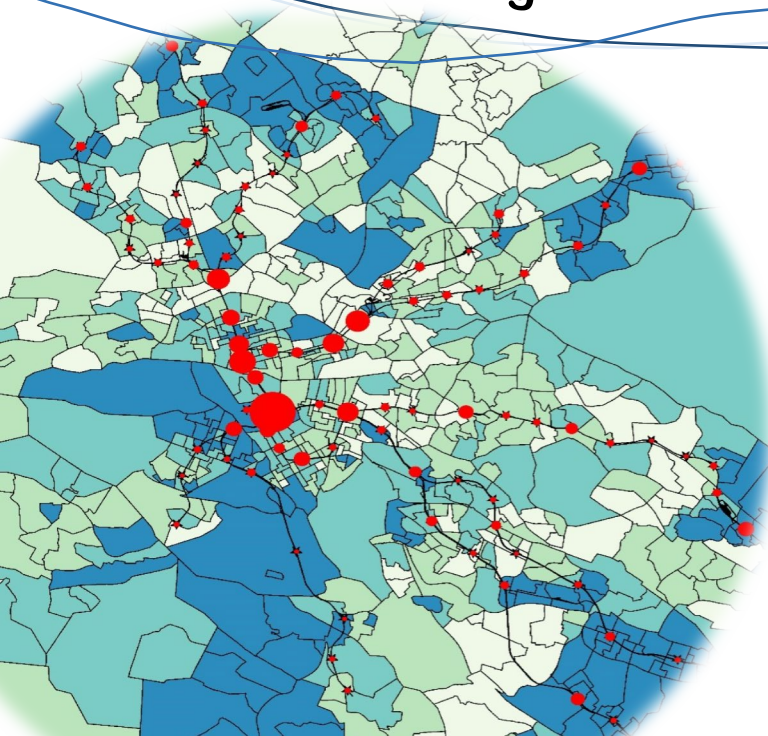
Integrates interdisciplinary perspectives and sustainability - oriented thinking, considers diverse city users, and engages with pressing societal challenges to enhance resilience.



UCS - URBAN AND COMMUNITY SAFETY RESEARCH

We create digital tools and data analysis, including GIS, AI models, sensors, and virtual reality, while testing real -world interventions to detect patterns and analyse how the built environment influences safety, active mobility, inclusion and health under existing and future scenarios.

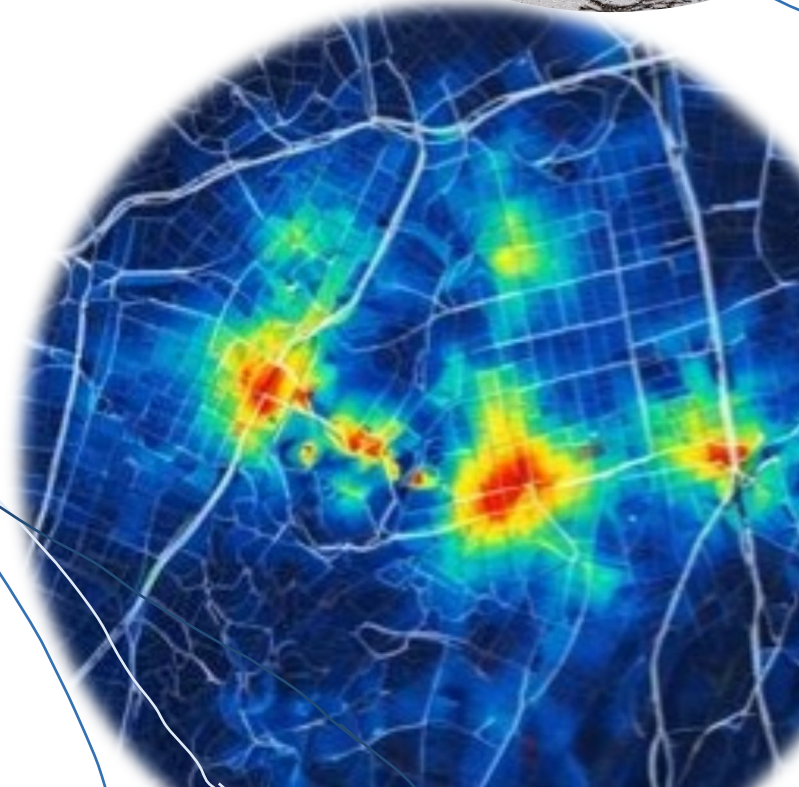
#AI_modelling



#Pattern_detection

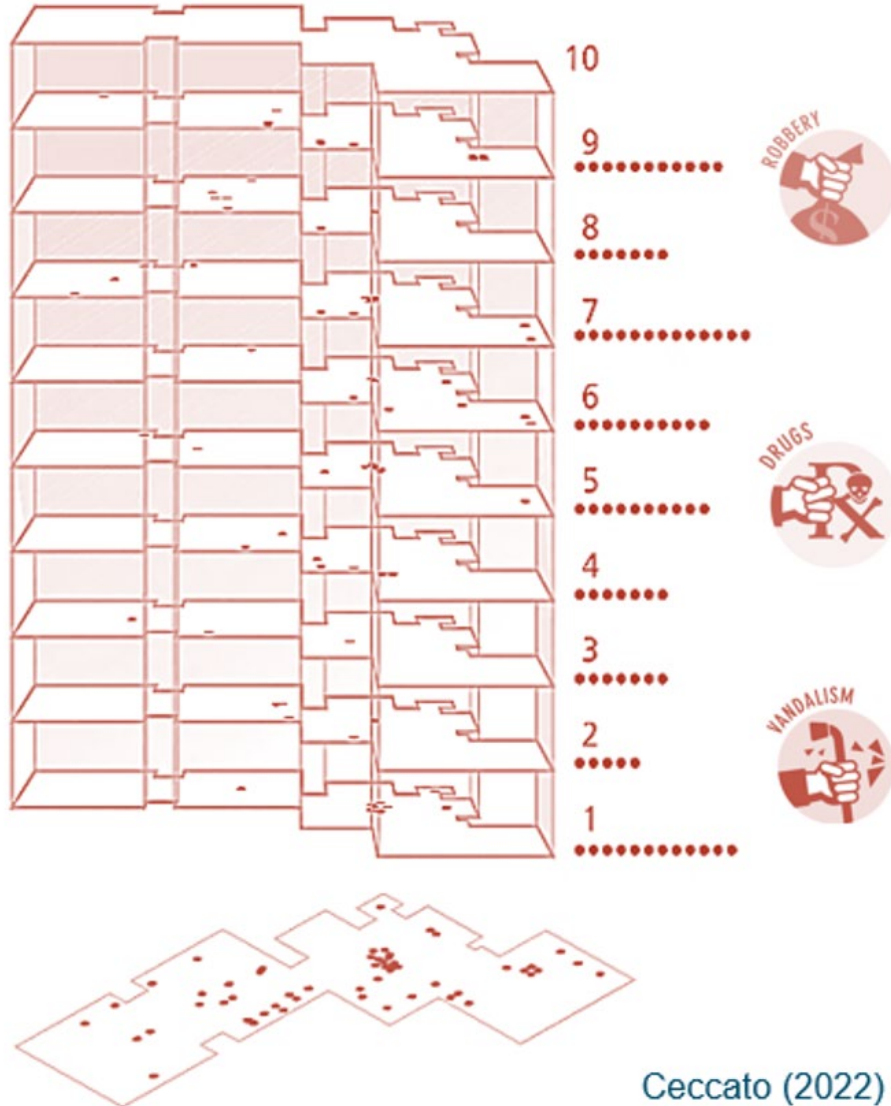
By combining digital tools, real world testing, and a strong city - user perspective, the platform bridges research and practice to generate knowledge for evidence-based interventions and strengthen urban resilience.

#VR_for_SafeCities

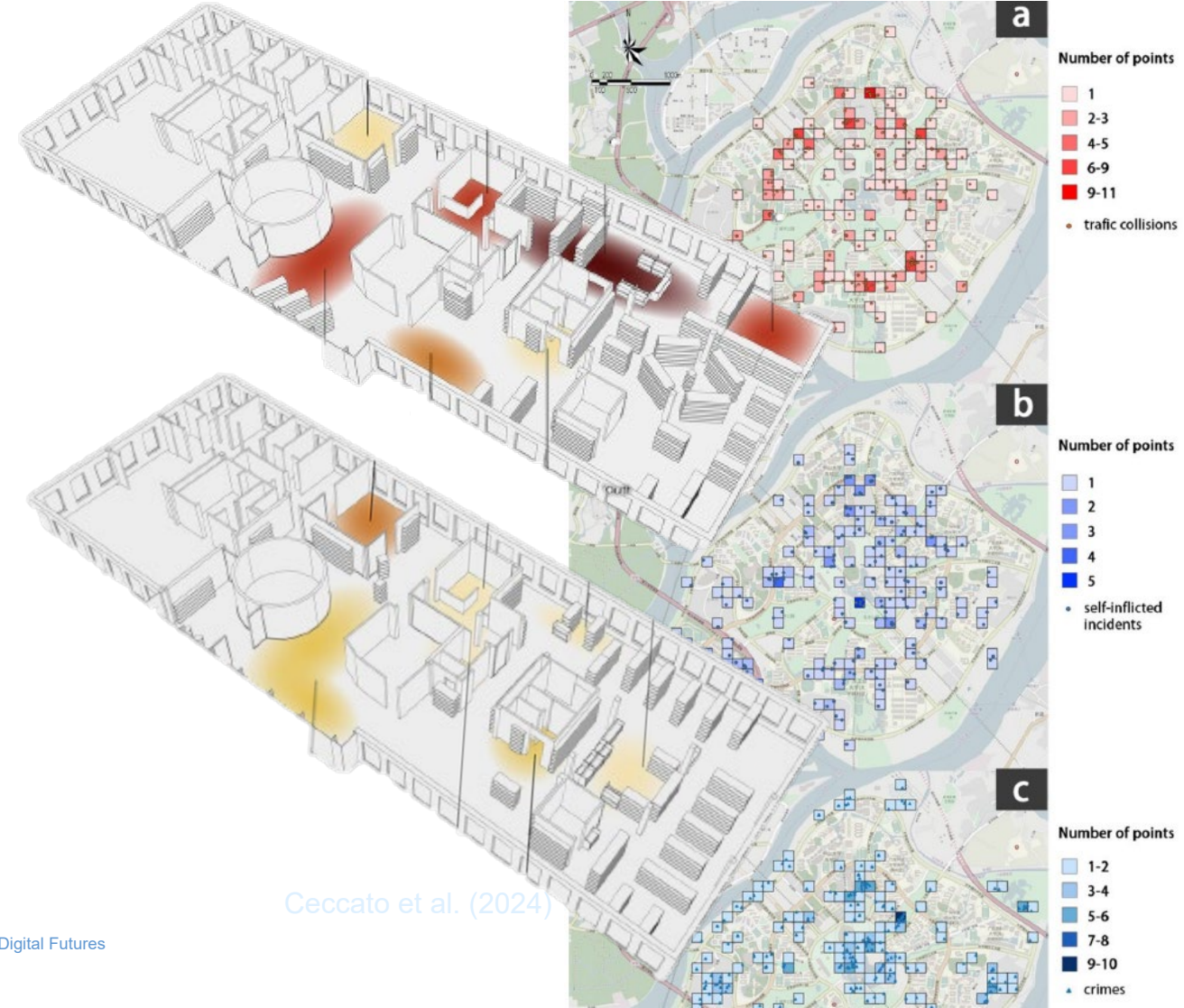


Before and after ... andbeyond

3D Digital Twin

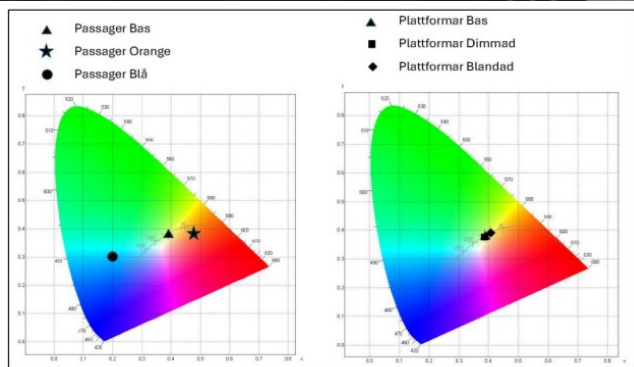
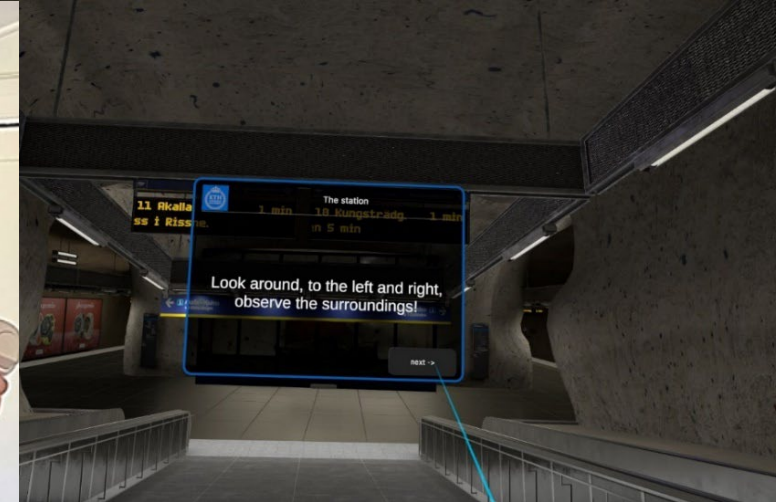


Ceccato (2022)



Ceccato et al. (2024)

Experiment in virtual reality (VR) scenarios



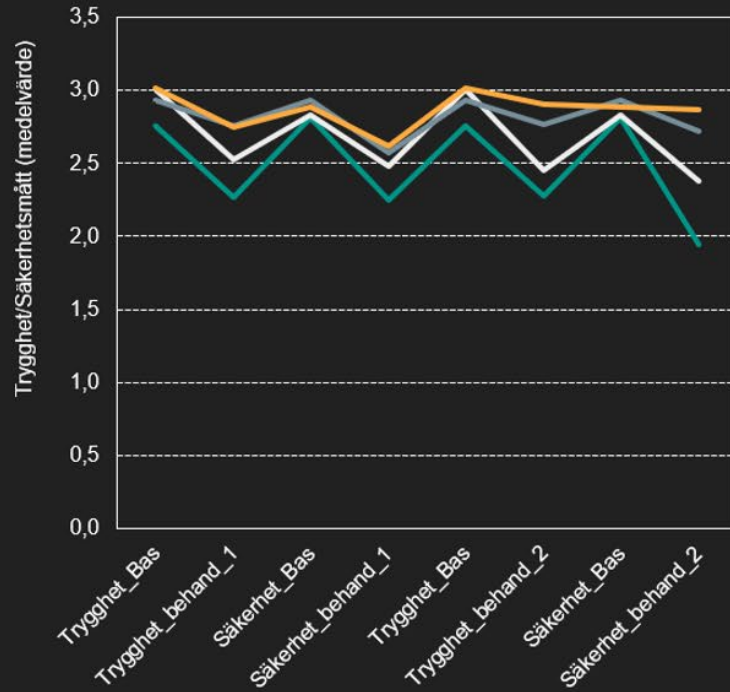
(a)

(b)



Virtual reality + safety of city users

Yes. They felt less safe/secure than those visually able.
For example, the safety scores for the non-visually impaired group range from 2.522 to 3.013, while the scores for the visually impaired group tend to be lower, ranging from 1.944 to 2.936.

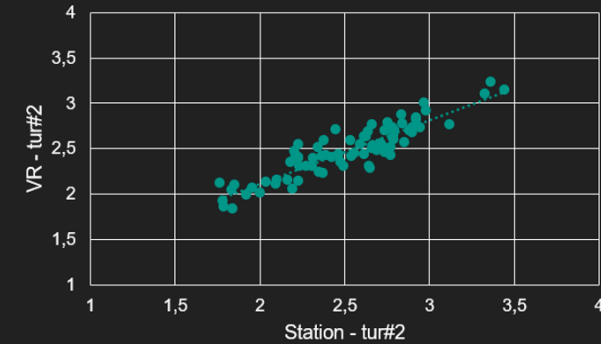
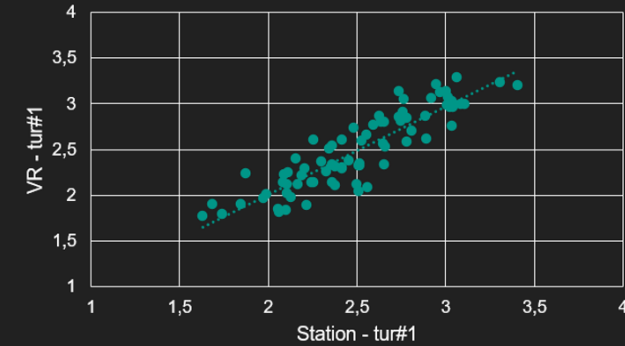


In entry spots, they felt less safe in orange-blue spots than in the baseline spot (normal light). Differences between station and VR experiment.

Passage_Synskad
Passage_Ej_synskad
Plat_Synskad
Platf_Ej_synskad

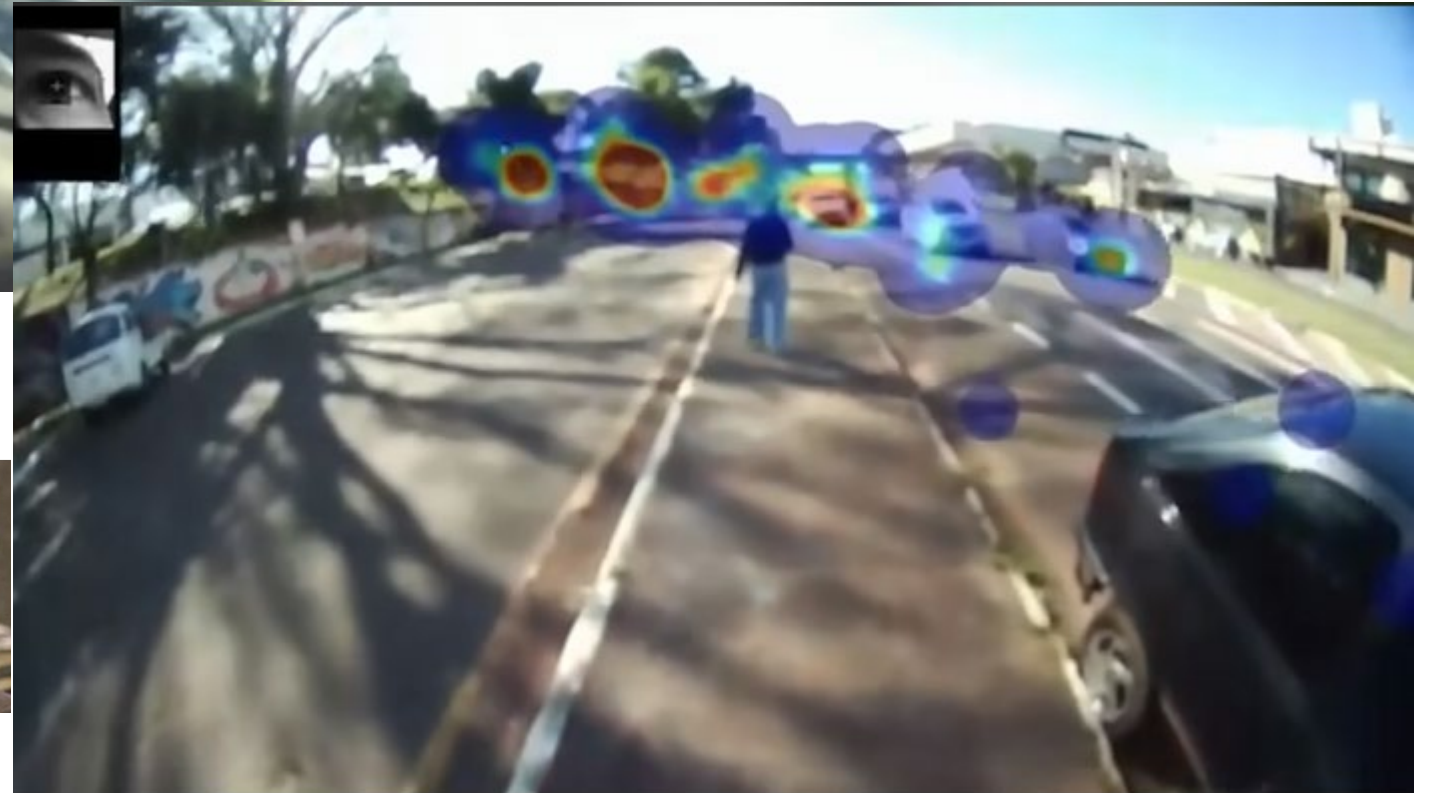
Especially low in blue passage

Passager & plattform - bas och behandlad punkter



Eye Tracking Glasses in a real urban environment

The system was operated using a mobile Wi-Fi modem and smartphone integration



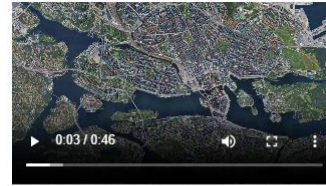
Lara Reis Rodrigues
& Profa. Ana Paula
Larocca
University of São Paulo,
Brazil



UCS - List of research projects



[Do place managers matter for safety?](#) Försäkringar, 2023-2025.



[Development of remote analysis data use for planning safe environments.](#) FORMAS, 2020



[Assessing the importance of light conditions for safety in transit environments: Fieldwork experiments and virtual reality scenarios \(VR\).](#) Region Stockholm, 2023 – 2024.



[Under what circumstances does cannabis use and trafficking occur?](#) Region Stockholm, 2020-2021 [in Swedish]



[Sensing safety perceptions in and around Kista: A temporal perspective of place users.](#) 2023 – 2024



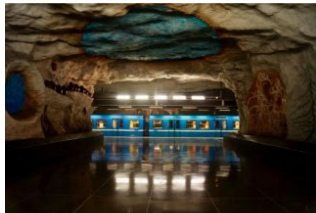
[Promoting security in the library's environment: An evaluation of Högskolan's model.](#) Brottsförebyggande rådet, BRÅ, 2020-2021 [in Swedish]



[Rural perspectives on crime and justice: A global analysis of victimization, safety and policing](#)



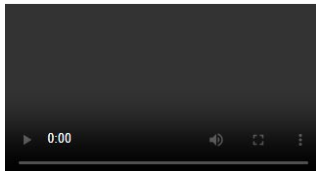
[Criticism, crime and threats against Swedish animal production.](#) the Federation of Swedish Farmers, LRF, 2019-2021



[The effect of the station environment for crime and passenger safety.](#) Trafikverket, 2021-2023 [in Swedish]



[Blue Light in Green Surroundings: Challenges and opportunities for emergency and rescue services in Sweden.](#) FORMAS, 2019-2022.



[AI, built environment and patterns of safety perceptions in Stockholm.](#) the project is part of Senseable Stockholm Lab, 2021-2022



[Transit safety among college students: An international study.](#) 2018-2020.

What lies behind the research?

- Data & Methods for Crime Science





Data for safer places

From the city to the building – integrating data for crime science

Ioannis Ioannidis

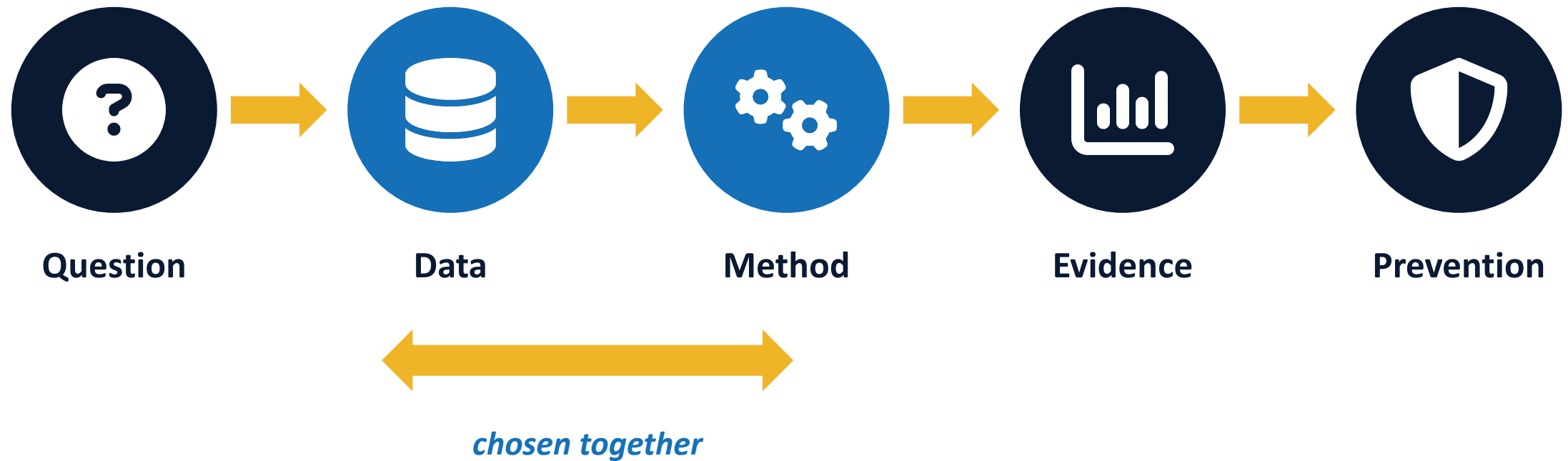
Urban and Community Safety Research Group · KTH Royal Institute of Technology

Session: Urban Environment, Place Management and Safety

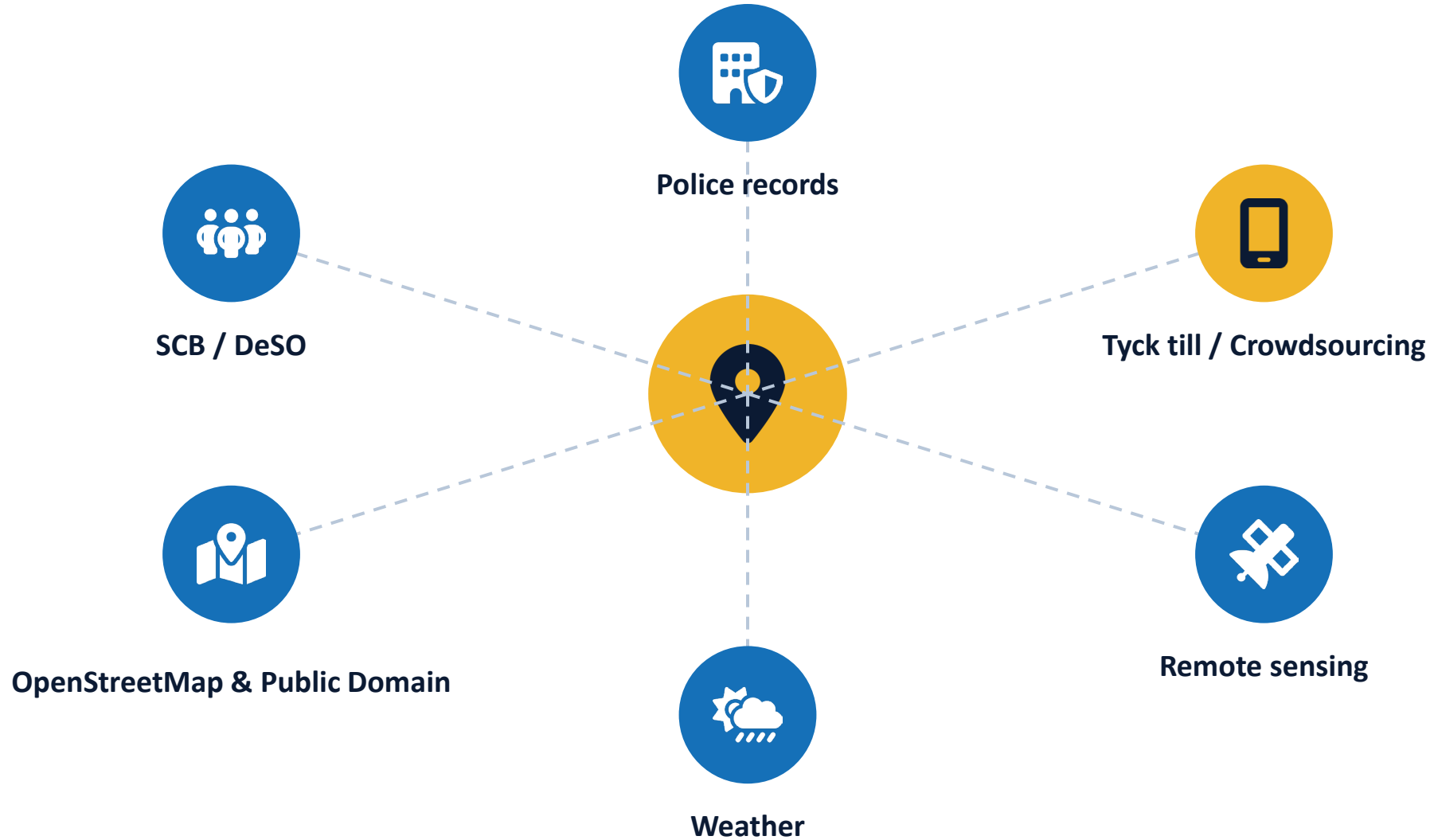


Crime science runs on data

Evidence-based = data-dependent



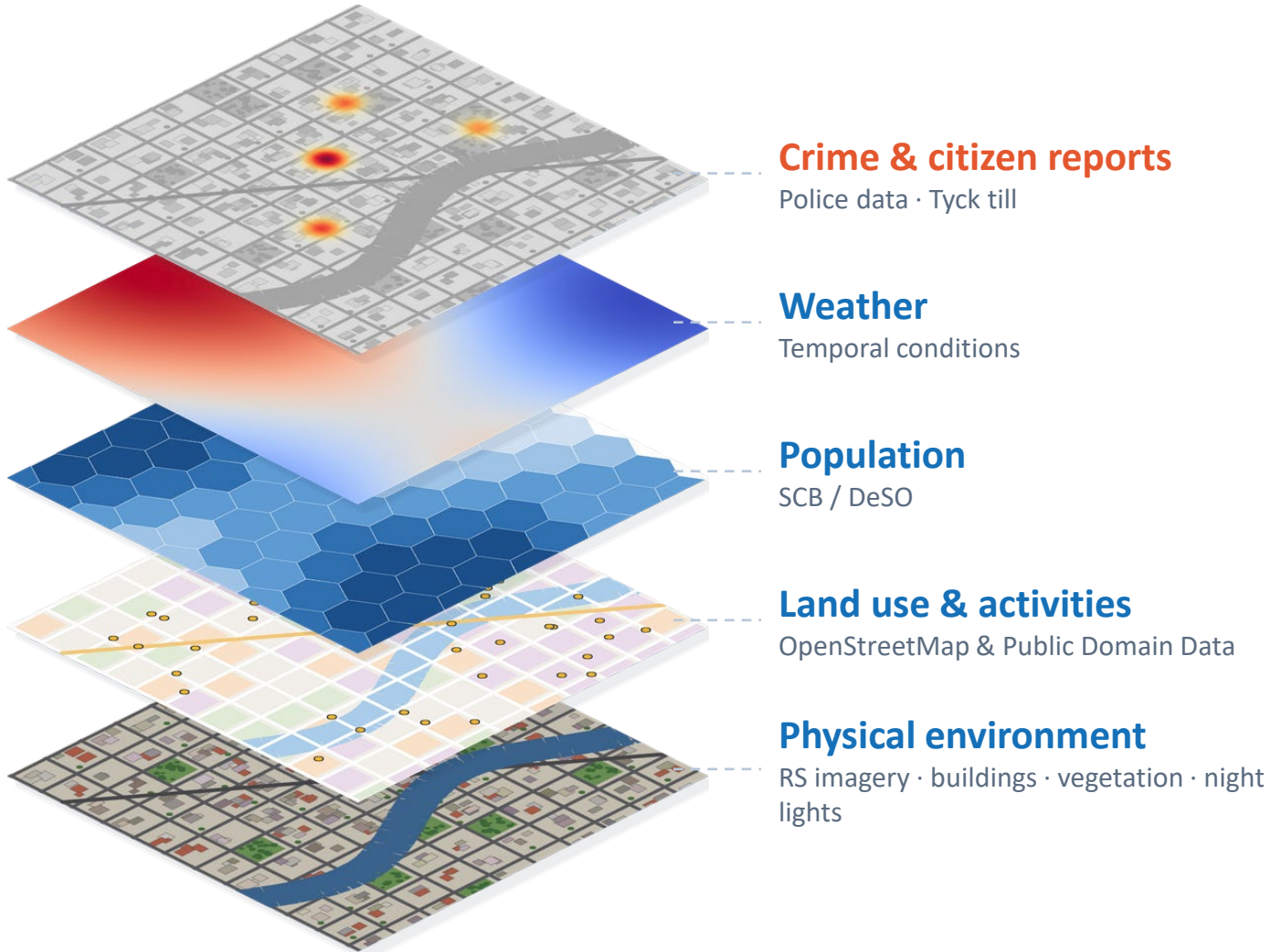
Data we can operationalise





The databases we are building

Stockholm · city → DeSO/Neighborhood → Street / Building



Linked places

Same places · DeSO → building · over time



Teaching

Students learn to build these datasets



GDPR

Agreements · pseudonymisation · aggregation

Detail

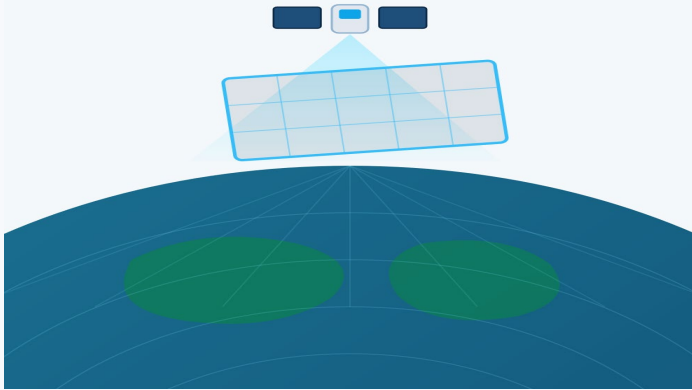


Privacy

part of the method choice

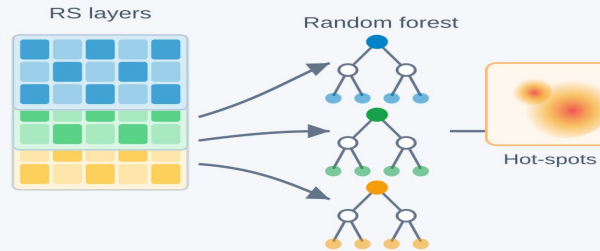
Advantages & Analytical Integration

RS Data – from a Worldwide picture to targeted prevention



Coverage

Worldwide and temporal picture without costly fieldwork

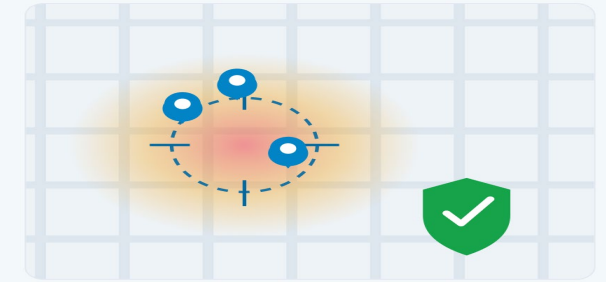


ML fusion · GeoAI

Raw RS → prediction

+ police · Tyck till · OSM · SCB · weather

Foundation models: fewer labels



Action

Risk maps for targeted situational prevention

Caution



Prediction $\neq$ explanation



Bias in = bias out



Transparency



Publication examples

Ioannidis et al. *Discover Cities* (2025) 2:122
<https://doi.org/10.1007/s44327-025-00171-2>

Discover Cities

RESEARCH

Open Access

Random forest modelling of remotely sensed land cover data to identify crime hot spots in urban areas

Ioannis Ioannidis¹, Andrea Nascetti¹, Vania Ceccato¹ and Robert P. Haining²

¹Correspondence: ioannis.ioannidis@kth.se
¹Department of Urban Planning and Environment, KTH Royal Institute of Technology, Stockholm, Sweden
²Department of Geography, University of Cambridge, Cambridge, UK

Abstract
This study evaluates the effectiveness of integrating high-resolution remote sensing (RS) data with machine learning (ML) techniques to identify criminogenic environments in urban areas. We employ an unsupervised ISO clustering method to classify land cover from aerial imagery, thereby capturing fine-scale environmental details that are often overlooked in traditional analyses. These clusters are linked to both crime and non-crime events through a presence/absence (case-control) framework, a methodology adapted from species distribution studies, which enables a micro-environmental examination of crime locations. In addition to RS-derived land-cover predictors, the study incorporates socio-economic and demographic variables, as well as a centrality indicator that proxies the intensity of urban activity. A Random Forest classifier is utilized to model the likelihood of street theft incidents based on these predictors. The model achieves robust performance, with an F1-score of 0.88 ± 0.03 as determined by K-fold cross-validation. To enhance model interpretability, SHapley Additive exPlanations (SHAP) is applied. The findings of this research demonstrate that integrating RS data with ML techniques offers a valuable tool for identifying and mapping criminogenic environments. The resulting risk map of Stockholm highlights key urban areas with elevated street theft risk, offering guidance for targeted crime prevention and urban planning strategies. While our workflow simplifies some technical steps compared to other RS+ML pipelines, it still requires GIS and ML competence to implement effectively. This approach reduces, but does not eliminate, sensitivity to spatial unit choice (MAUP) and spatial data dependencies.

- Highlights**
- Characteristics of the urban environment extracted from remote sensing data help to predict criminogenic environments for street theft.
 - Development of a case-control methodology, studying crimes as point events to minimise the effects of the Modifiable Areal Unit Problem (MAUP) while linking each crime event to the characteristics of its immediate area.
 - Random Forest models can accurately detect criminogenic environments of street theft.



Cartography and Geographic Information Science

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Using remote sensing data to derive built-form indexes to analyze the geography of residential burglary and street thefts

Ioannis Ioannidis, Robert P. Haining, Vania Ceccato & Andrea Nascetti

To cite this article: Ioannis Ioannidis, Robert P. Haining, Vania Ceccato & Andrea Nascetti (2025) Using remote sensing data to derive built-form indexes to analyze the geography of residential burglary and street thefts, *Cartography and Geographic Information Science*, 52:3, 259-275, DOI: [10.1080/15230406.2023.2296598](https://doi.org/10.1080/15230406.2023.2296598)

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Tunnelling and Underground Space Technology 159 (2025) 106482

Contents lists available at ScienceDirect

Tunnelling and Underground Space Technology
incorporating Trenchless Technology Research

journal homepage: www.elsevier.com/locate/tust

Graffiti in pedestrian tunnels: A comparison of police records and crowdsourced data in Stockholm, Sweden

Vania Ceccato^{a,*}, Ioannis Ioannidis^a, Marcus Felson^b

^a UCS, Urban and Community Safety Research Group, Department of Urban Planning and Environment, KTH Royal Institute of Technology, Stockholm, Sweden
^b Texas State University, USA

ARTICLE INFO

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Crowdsourced data
Police records
Sustainability
Underpasses
Subsurface spaces

ABSTRACT

Using 1281 pedestrian tunnels scattered over Stockholm, Sweden's capital, we investigate the nature and distribution of graffiti in three types of underpasses (pathways, cycleways, and stairways). Combining crowdsourced data and police records, we compare graffiti levels and geography using fieldwork inspections, regression models, and Geographic Information Systems (GIS). The findings indicate that graffiti recorded to the police is present in only a quarter of the pedestrian tunnels, suggesting that recorded practices are concentrated in specific underpasses. Graffiti is more commonly found in larger tunnels, particularly cycling underpasses. Proximity to metro stations, schools, and the presence of young males in the area are factors linked to graffiti occurrence, although not consistently. These results highlight the complexities of relying on graffiti records for public space management, particularly the challenges professionals face in aligning the maintenance of pedestrian tunnels with urban sustainability goals.

1. Introduction

Managing graffiti in public spaces is a challenge. This article focuses on graffiti in public underpasses, commonly called "pedestrian tunnels" in Sweden. These "subsurface spaces" (Volchko et al., 2020) include footpaths, stairways, and cycleways and are often designed to enable pedestrians and cyclists to access underground crossroads, stations, parking lots, and other key locations. Our study is based in Stockholm, the capital of Sweden, where road-related facilities, such as pedestrian tunnels, are frequently targeted by graffiti. These incidents are documented either by the police or through a crowdsourcing app that allows citizens to report occurrences, share opinions, and provide suggestions on various urban issues.

In a paradoxical incident in the summer of 2023, a call to the police reported that a public underpass, or a "pedestrian tunnel", as we call it, was vandalised. However, upon the police's arrival, it was revealed that the graffiti was a summer artwork project by young people commissioned by the municipality as part of the youth job programme. This incident serves as an example of the starkly different perceptions of graffiti in pedestrian tunnels and the challenges of satisfying conflicting urban sustainability goals.

Graffiti in pedestrian tunnels holds a unique position in the broader

context of graffiti as an art expression. Pedestrian tunnels, often found in urban environments, provide a somewhat protected space from the elements and the public eye, making them attractive sites for graffiti and an obvious place for display (Ceccato et al., 2025). The Oxford Dictionary defines graffiti as "drawings or writing done on a wall, in a public place without permission." However, this definition falls short of capturing the full spectrum of graffiti. Not all scribbles on a wall are artwork (often called tags), yet we know little about what makes people complain about graffiti as physical damage to public property. The eye of the beholder is a phrase that is fitting in the case of graffiti because 'something' in this case is a matter of personal opinion, even if it is done with permission.

Graffiti incidents are conventionally reported to the police, regardless of where they occur. More recently, mobile apps have provided a convenient, quick means of information sharing and the opportunity to upload photos of incidents. This information is then relayed to urban planners and technicians responsible for the city's maintenance. In contrast, police reports ensure official documentation and potential legal follow-up. However, despite these reporting methods, we still have a limited understanding of how graffiti is reported, highlighting the need for further research in this area.

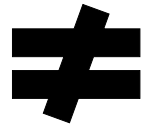
Graffiti plays a significant role in underground space design,

What environments feel safe - and how do we measure it?

**Fear of crime and safety perceptions in
Crime science**

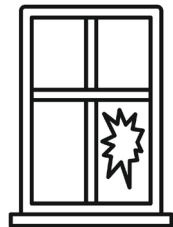
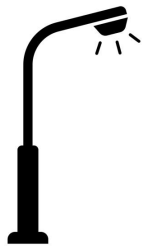
Fear of Crime in the built environment

CRIME



FEAR OF CRIME

Places that have low crime rates can still be perceived as unsafe due to, for instance, the physical and social conditions of the built environment



To Measure Crime vs Fear of Crime

What counts as evidence?

CRIME

FEAR OF CRIME

"OBJECTIVE"

SUBJECTIVE

Legally defined



Crime events/rates

Defined time and
place

Police records

Fear of what
exactly?

Where?

XY-coordinates?
Time-stamps?



Surveys?
Interviews?

Data sources?

Intensity vs frequency?

What tools do we have to measure fear?

AI and street view images for a spatial measure of safety

Vilken av miljöerna känns mest trygg?
Var vänlig klicka på bilden som känns mest trygg.

Visar 1 av 10



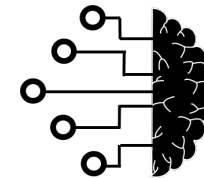
~4000 Street View images

Citizens
panel

~2400 respondents

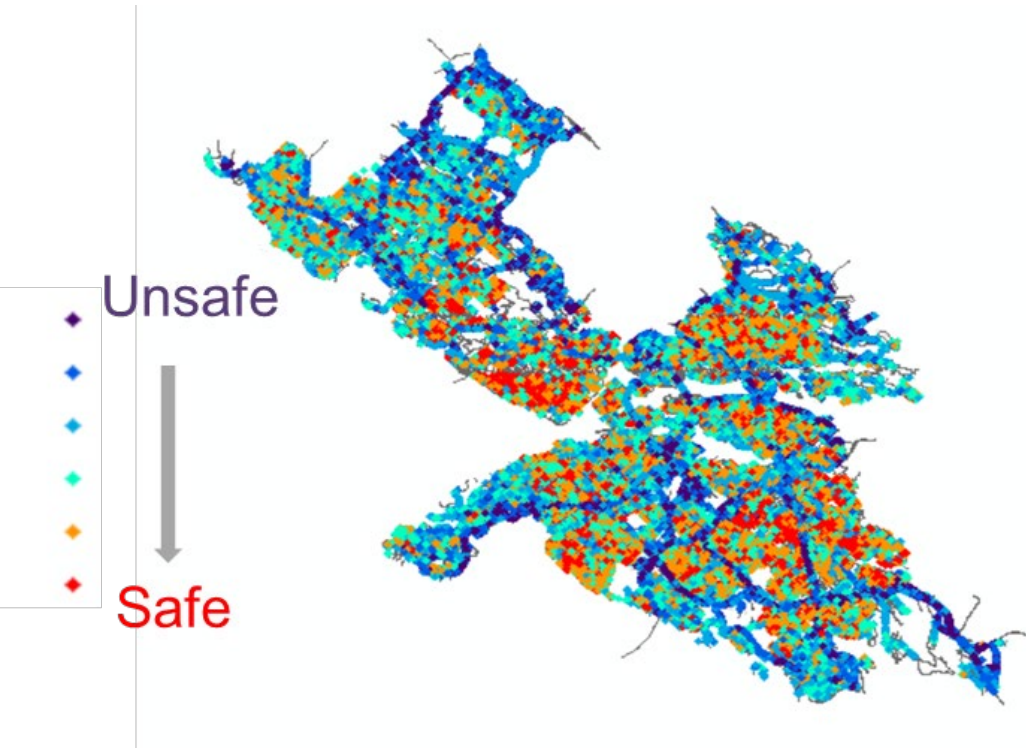
Survey:
Perception of GSV-images
"Most Safe" / "Most Unsafe"

Training of deep
learning/computer vision
model

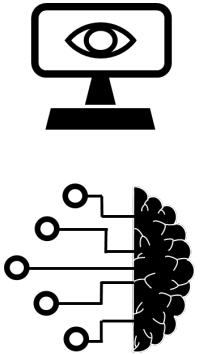


Model predicts the GSV -
images'
Perceived Safety Score
based on survey rankings

A map of perceived safety



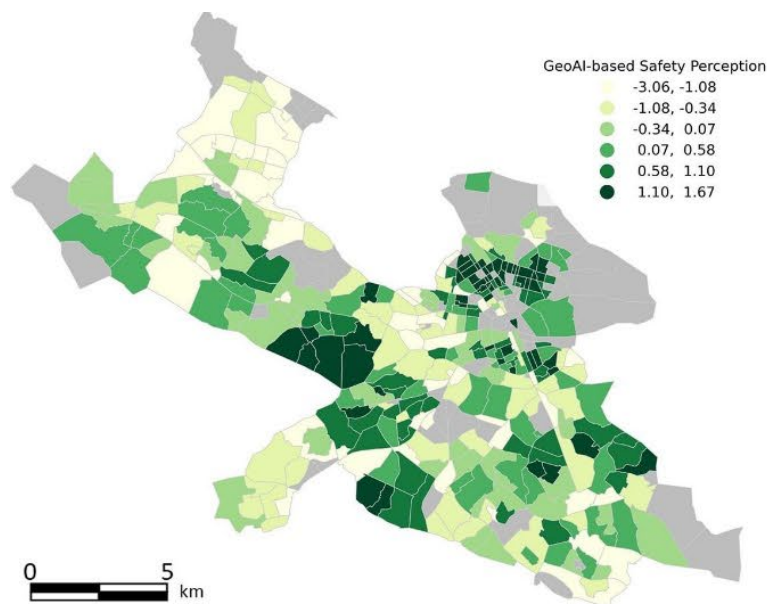
Low safety score



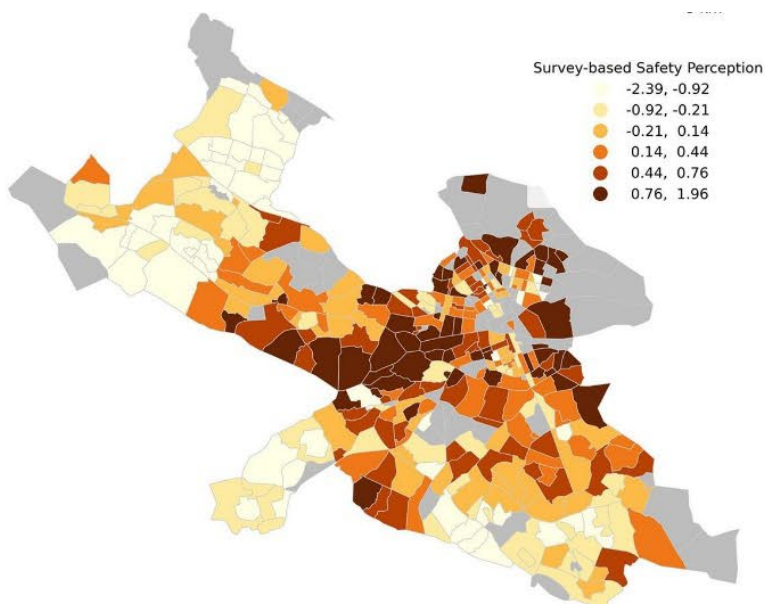
High safety score

Comparisons with other safety indicators

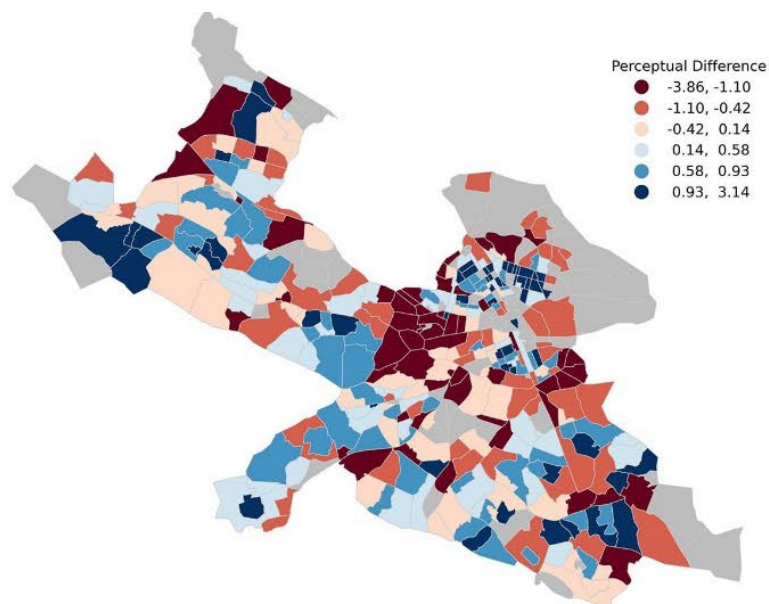
AI Safety Score



Stockholm Safety Survey



Differences between measures



Global, Instant, temporary impressions

Local, long-term, experiences

Perceptual difference

Crime and Visually Perceived Safety of the Built Environment: A Deep Learning Approach

Jonatan Abraham,^a Yuhao Kang,^b Vania Ceccato,^{a,b} Per Näsman,^a Fábio Duarte,^c Song Gao,^d Lukas Ljungqvist,^e Fan Zhang,^c and Carlo Ratti^{c,f}

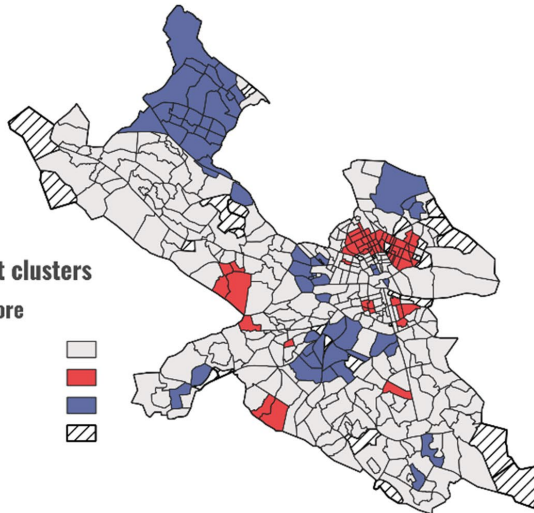
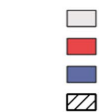
Comparisons with other safety indicators

Hot/cold spots of safety vs crime

Spatial significant clusters

Perceived safety score

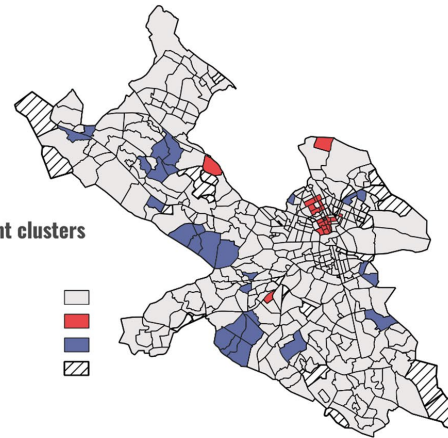
Not significant (270)
High (62)
Low (56)
N/A



Spatial significant clusters

Total Crime

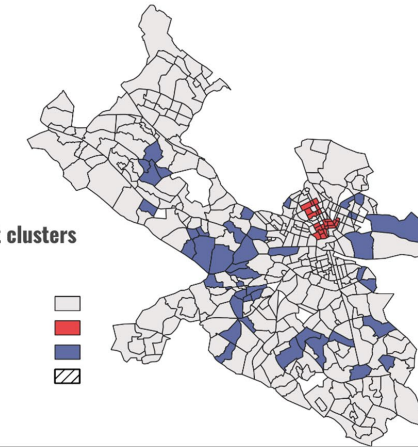
Not significant (337)
High (23)
Low (28)
N/A



Spatial significant clusters

Violent Crime

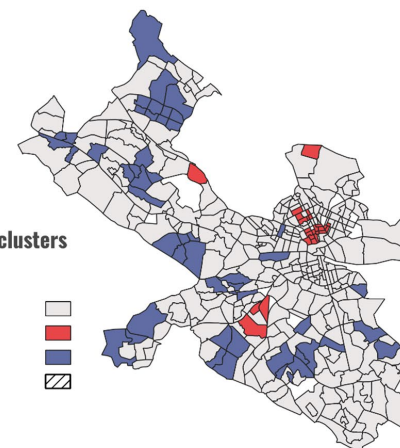
Not significant (321)
High (23)
Low (44)
N/A



Spatial significant clusters

Street Theft

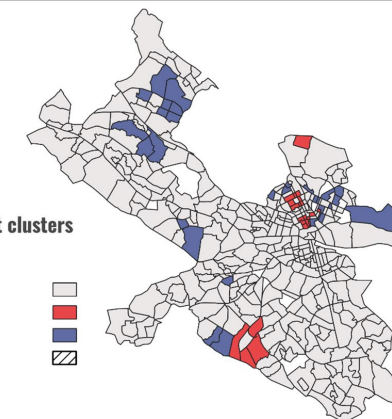
Not significant (310)
High (26)
Low (52)
N/A



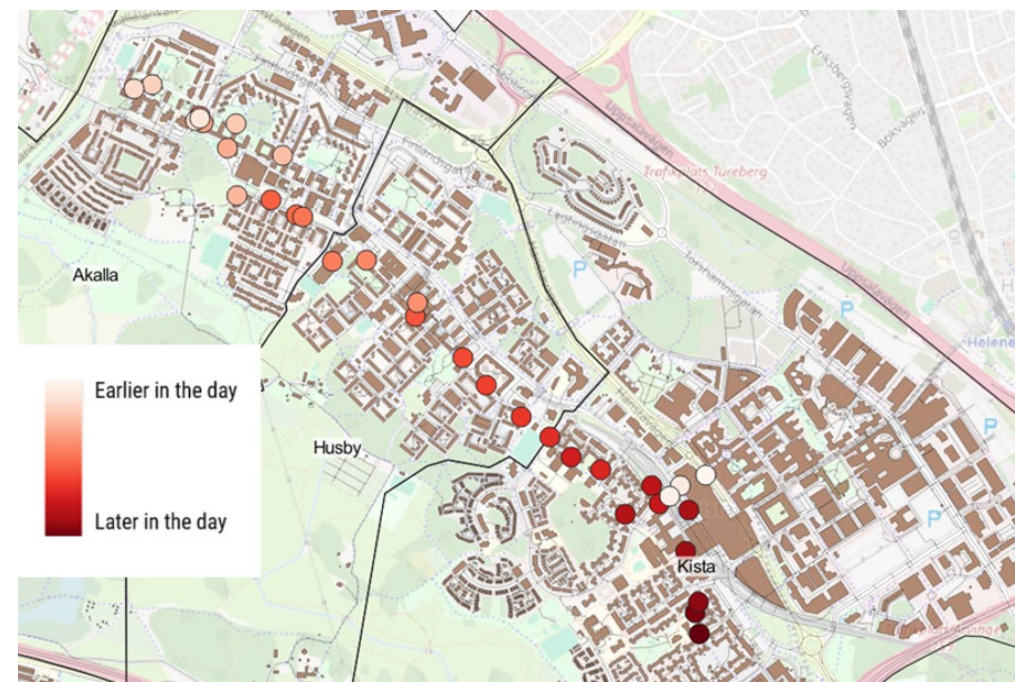
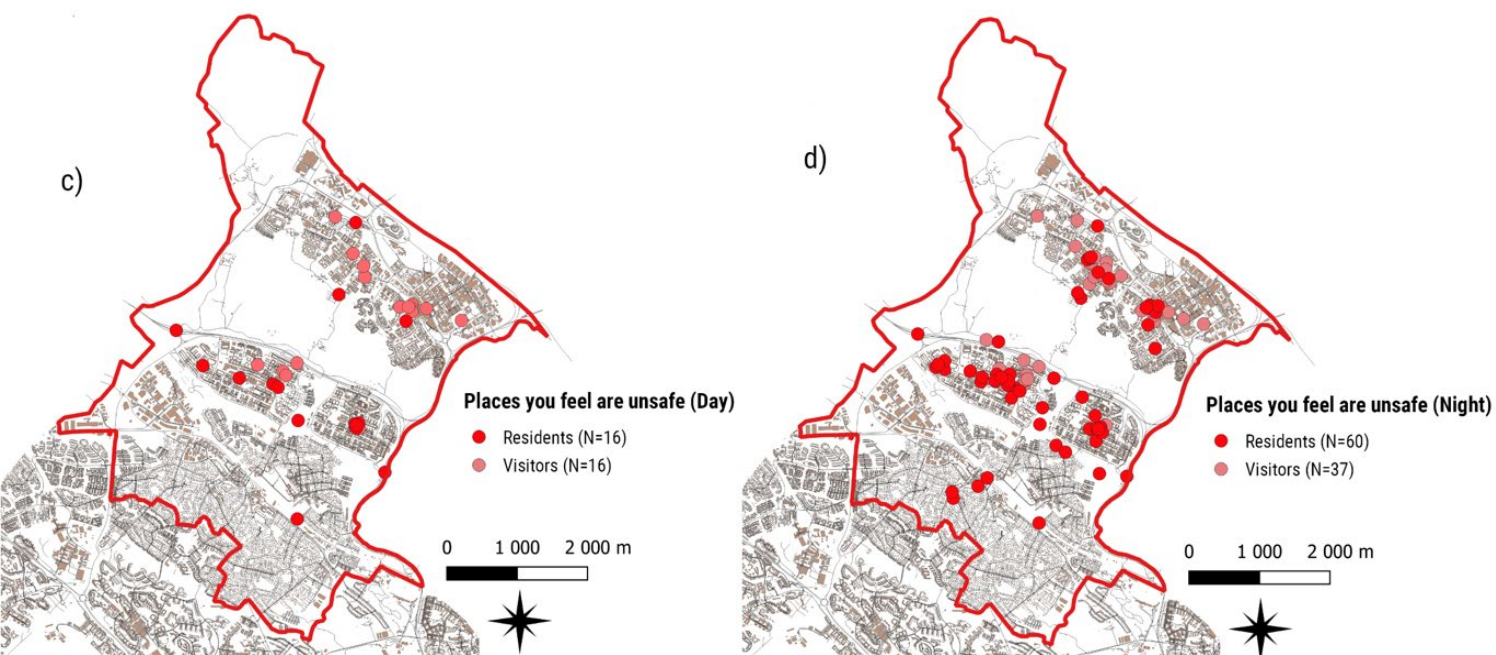
Spatial significant clusters

Vandalism

Not significant (336)
High (22)
Low (30)
N/A



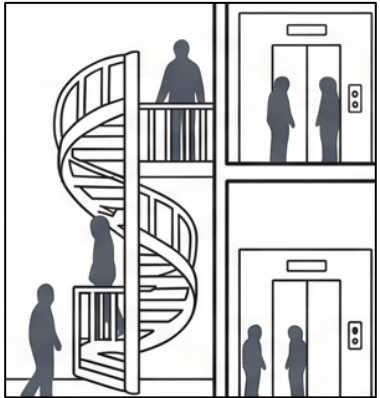
Relational and dynamic understanding of safety



Context and scale of place for safety



Private



Semi-public



Public

Each context has
different users,
stakeholders and
responsible owners,
and different
conditions for crime
and fear



Building



Neighborhood



Rural



City

Who makes places safe?

- Place managers, crime, and safety in the residential building

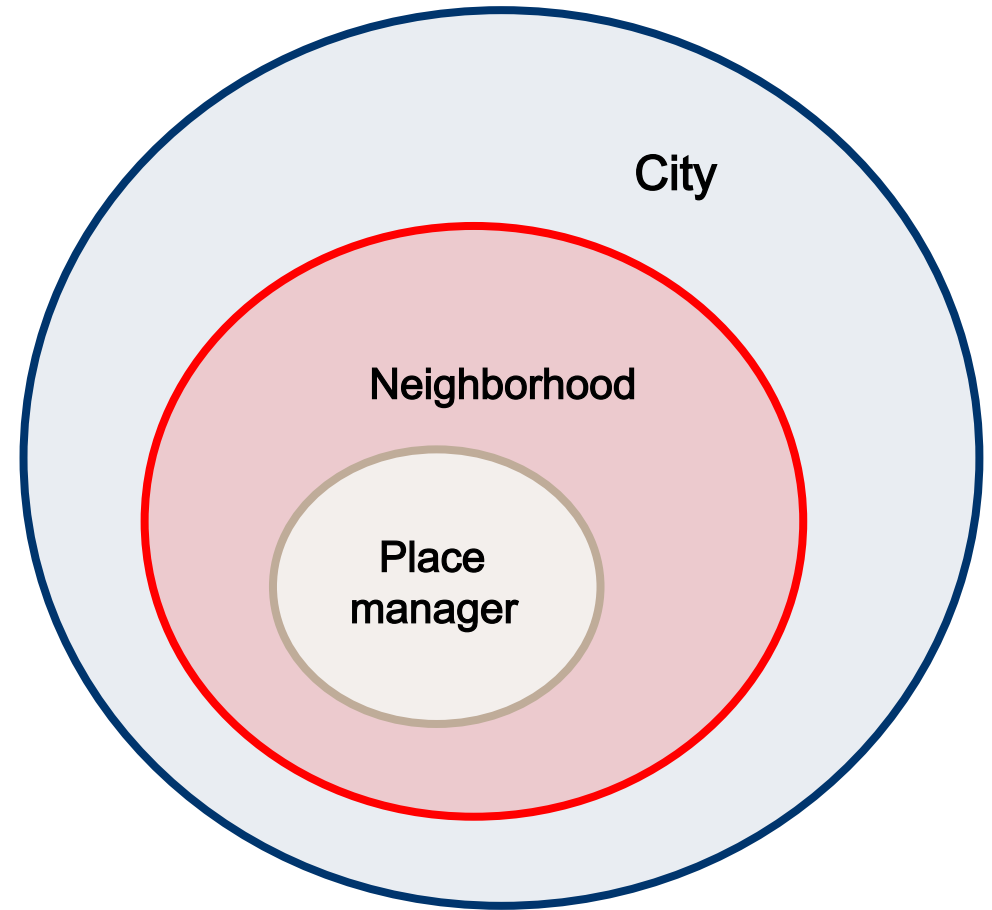


Creating safety over time

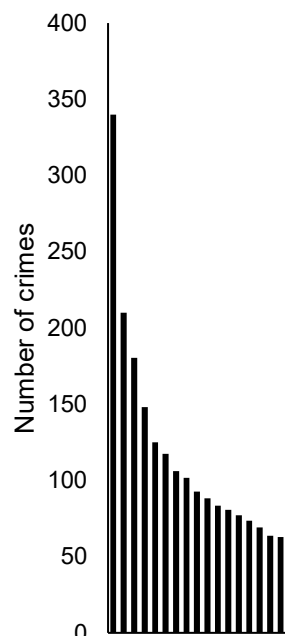
How a place is being *managed over time* is an important aspect of creating safe spaces

Place management:

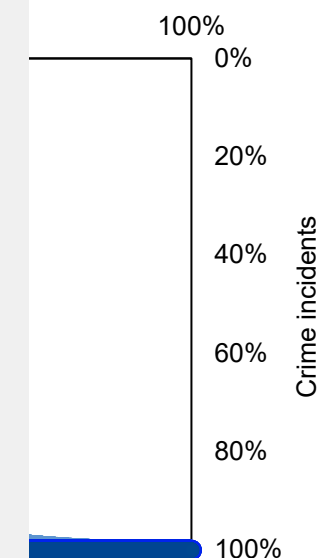
The practices involved in shaping, maintaining, and governing a place to influence how it is used and experienced.



We know that crime concentrates to certain places



Property and violent
(Sept. 1, 2003–Aug)



(Gini = 0.75)

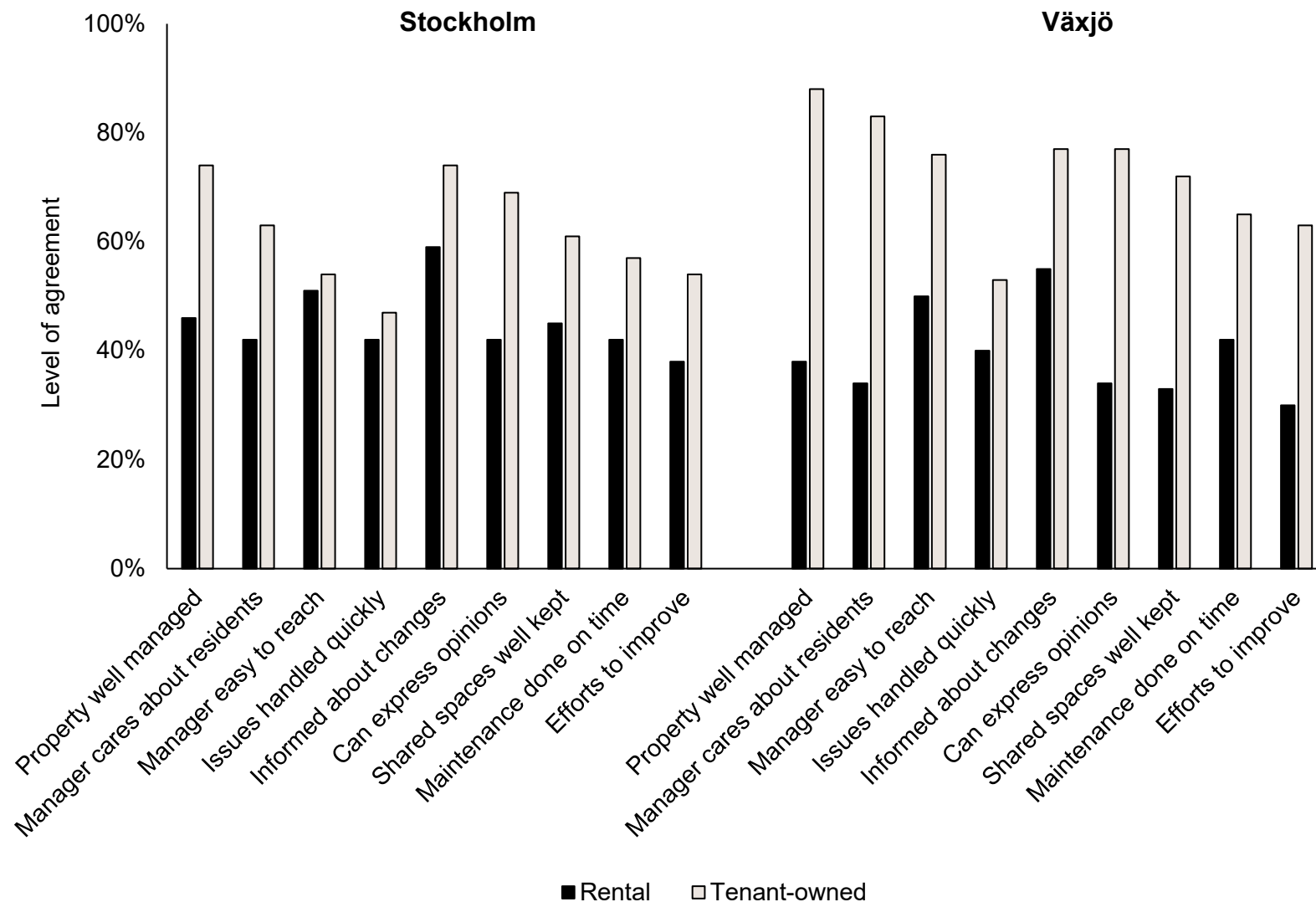
= 0.68)

es (Gini = 0.79)

companies and
t count).

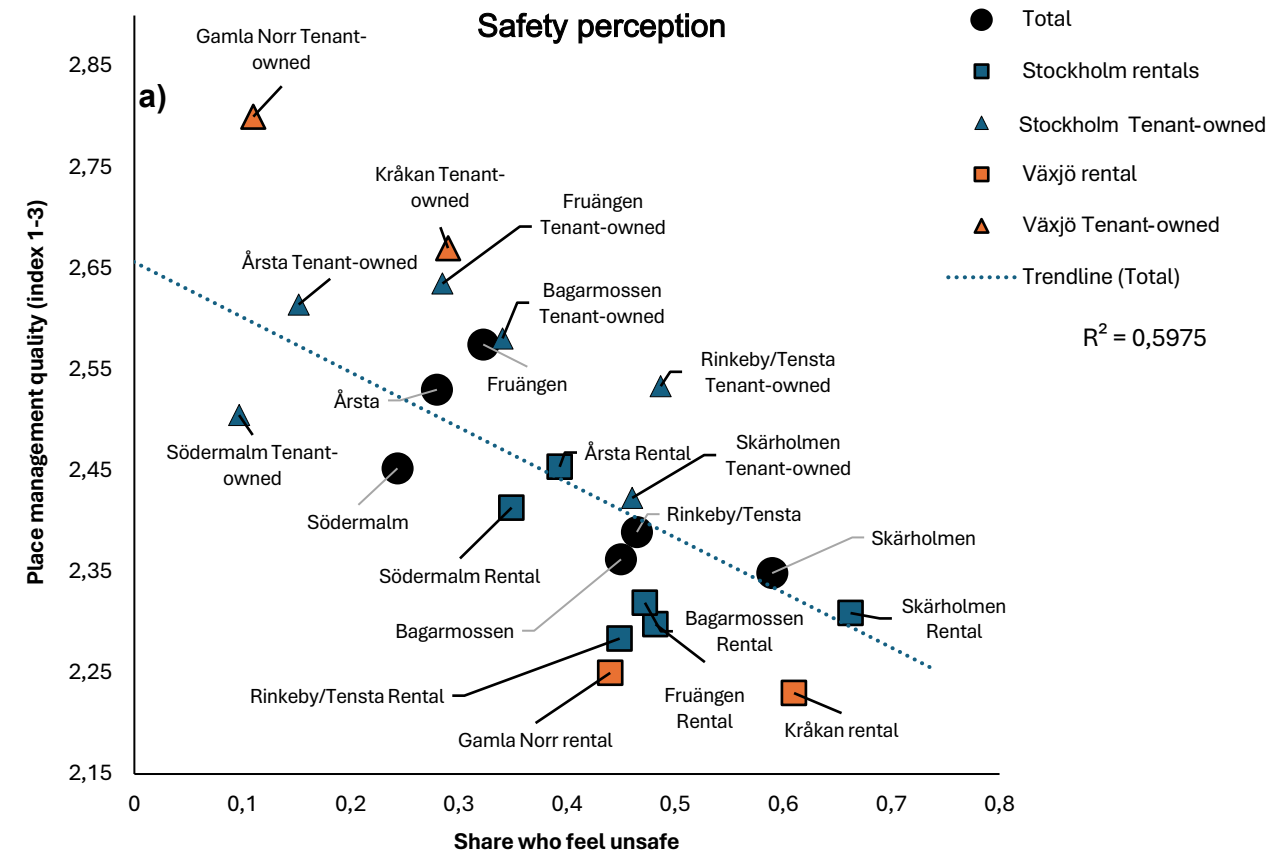
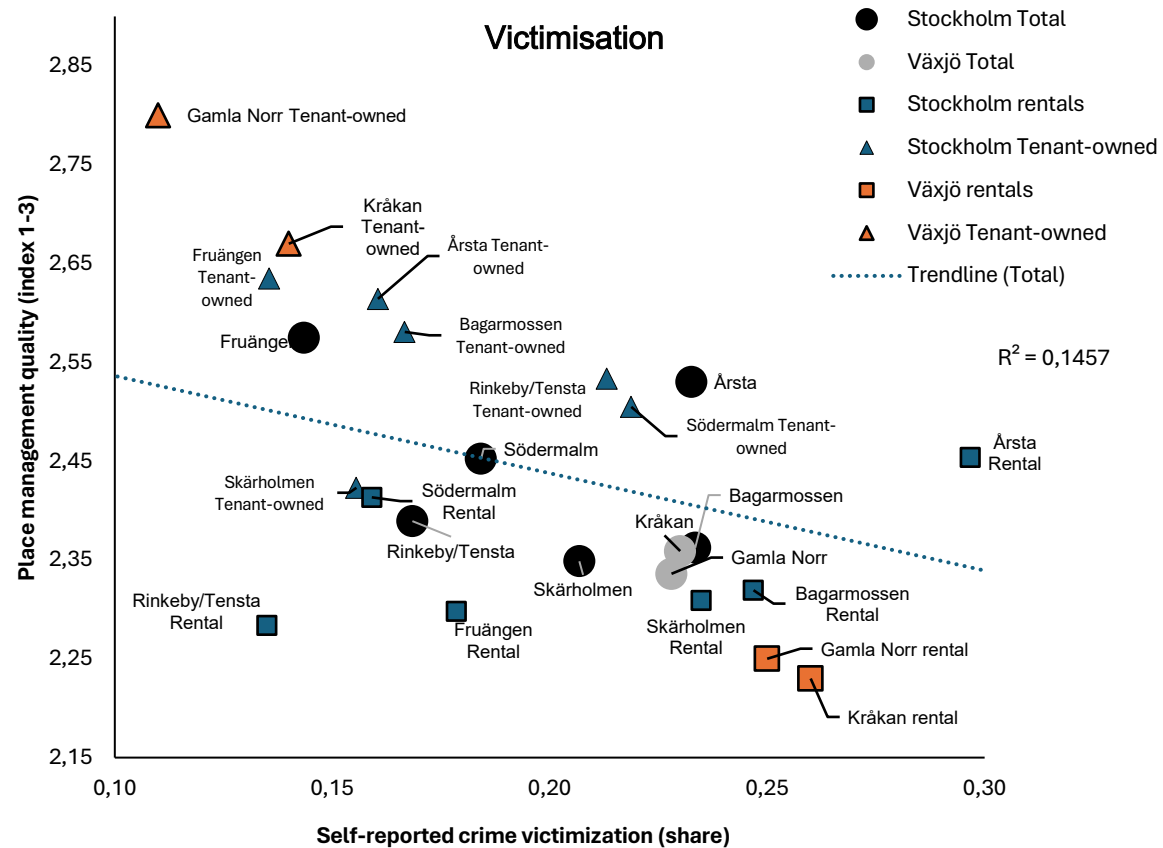
Our research also shows that there are variations in experiences of place management

Both between *buildings*...
tenure forms...
and *cities*



What effect does management have on safety and victimisation?

Using our index of residents' experiences of place management, we found a correlation with both victimisation and perceived safety!



Different management practices shape safety and victimisation

VICTIMISATION

Social activities in the neighborhood

Fewer social activities in the neighborhood are associated with higher levels of vandalism and property crime victimization .

PERCEIVED SAFETY

Maintenance and upkeep

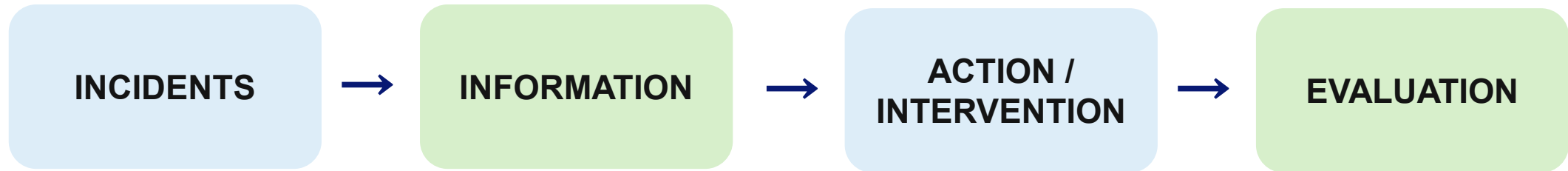
Poor physical upkeep of shared spaces is associated with greater feelings of unsafety . The same in both Stockholm and Växjö.

Factor	Victimisation	Perceived safety
Maintenance & upkeep	Not significant in Stockholm but significant in Växjö*	Strongest association (+35-45% higher odds with poor maintenance)
Organized social activities	Strongest association Vandalism odds increased by 4.39 Property crime odds increased by 4.08	Less prominent
Doors, alarms, CCTV, etc.	Unexpected inverse association; possible reverse causality	No key finding
Responsive & accessible manager	Less conclusive	Less conclusive

**results should be interpreted cautiously due to the small number of buildings*

Managing places requires knowing what happens...

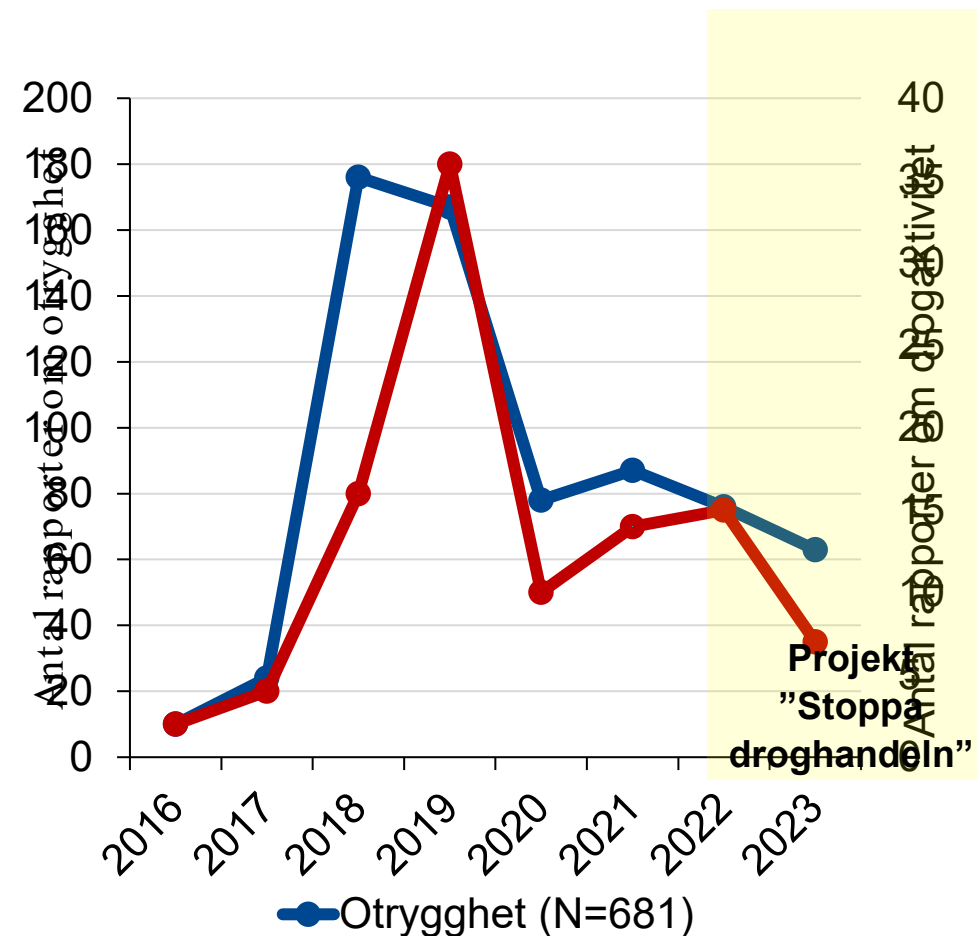
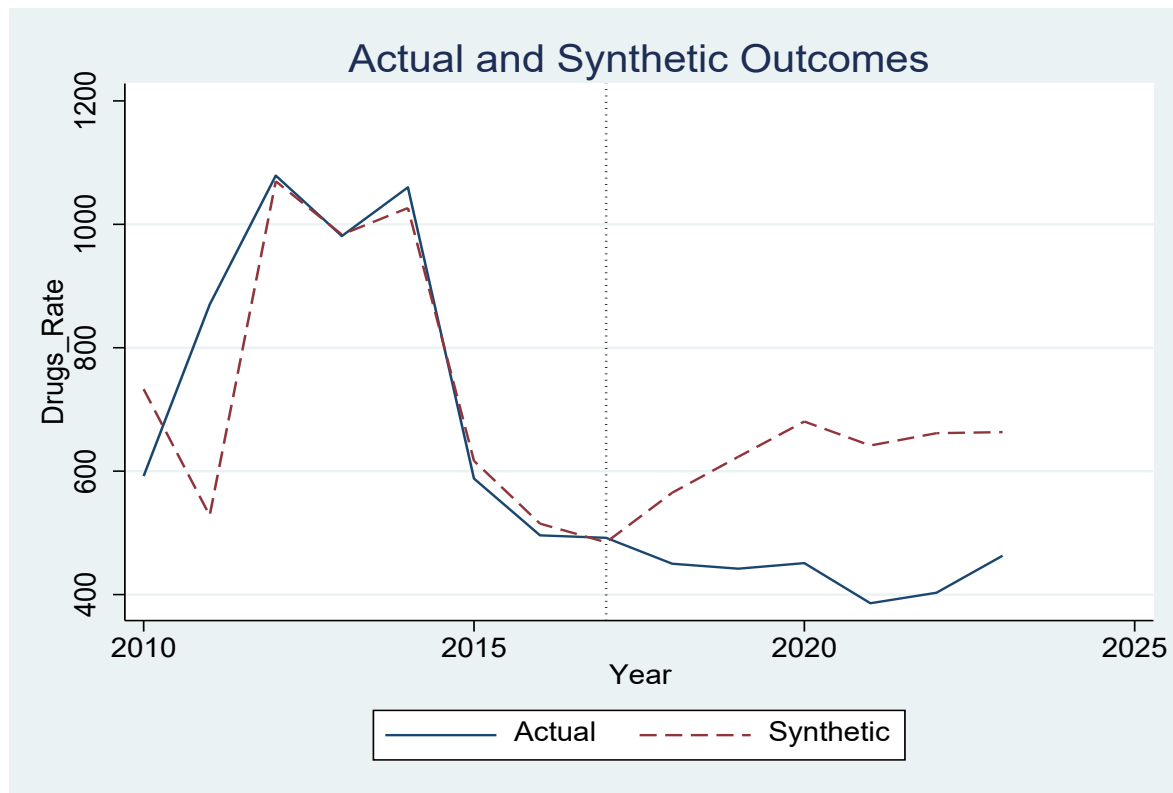
A key condition for acting over time is a shared picture of incidents and safety problems



In one of our studies of the Swedish railway system, we found that information was fragmented and responsibilities were unclear, making coordinated place management more difficult.

Managing places requires knowing what happens...

...and the effect of the interventions



Place management is therefore not only about interventions but also learning and assessing

→ Safe places require active place management over time.

Summary



A callback from this morning:

'Crime science is the application of scientific methods and knowledge from many disciplines to the development of practical and ethical ways to reduce crime and increase security'

At KTH we incorporate crime science through:

- *Combining a range of data and applying mixed methods , from surveys, interviews and GIS mapping to virtual reality and deep learning, to analyse crime and community safety in the built environment systematically*
- *Drawing on criminology , urban planning, geography and other disciplines to build an integrated evidence base for place-based crime prevention*
- *Developing knowledge with and for practice , working with housing companies , municipalities and other authorities to turn research into action*



Thank you



Give us feedback!

